Nuclear Experimental Group II(Annual Report)

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Nuclear Experimental Group II

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Research Activities

a. The Space-Charge Effect in a Single Wire Position-Sensitive Proportional Counter II (K. Kageyama, S. Hayashibe, M. Fujioka and M. Kanazawa)

The pulse height variation in a position-sensitive proportional counter which depends on the incident position of α-rays has been examined by a computer simulation. The results show that the observed variation is explained by taking into account the self-induced space-charge effect in the avalanche process. The main contribution to this effect was found to be the time distribution of drift electrons. To the time distribution is related the time spent in drifting from the location of production (extended ionization) to the anode. It was therefore concluded that the pulse height variation was described essentially by the space-charge effect due to the electric field dependence of drift velocity of the primary electrons.

b. Study of the Nuclear g-Factor and the Structure of the 2395 keV Isomer in ^{217}Ra (N. Kawamura, E. Tanaka, S. Hayashibe, S. Awano, T. Saitoh, M. Wada, T. Yamaya, M. Sugawara*, K. Kotajima**, M. Fujioka and T. Shinozuka***, *Chiba Institute of Technology, **Faculty of Engineering, ***CYRIC)

The nuclear g-factor of the 2395 keV isomer has been measured by the time integral perturbed angular distribution method of in-beam γ-rays through the ^{208}Pb(^{12}C,3n)^{217}Ra reaction at E(^{12}C)=67 and 70 MeV using the CYRIC cyclotron. We deduced a value of g=-0.074±0.048 from the weighted mean of the g-factors obtained at the two bombarding energies using a half-life of 3.88±0.10 ns as measured in the present work.

Comparing the present g-factor with values calculated for various configurations with the spin and parity of $33/2^+$, we propose that the isomer has a mixed configuration of two components of $((2_1^+$ in ^{214}Ra)$\otimes\nu g_{9/2}i_{11/2}^2)_{33/2^+}$ and $(\nu g_{9/2}j_{15/2}^2)_{33/2^+}$ nearly equal strength of 51±10 and 49±10 %, respectively.

c. Search for Short-Lived Neutron-Rich Nuclei Produced by Proton-Induced

Fission of ^{238}U with IGISOL (H. Sunaoshi, M. Wada, T. Shinozuka and M. Fujioka)

The observation of new neutron-rich isotopes in the $f_{7/2}$ region is of interest for astrophysics as well as for nuclear spectroscopy. To search for unknown neutron-rich nuclei, test experiments using an ion-guide isotope separator on-line (IGISOL) system coupled with the proton-induced fission of ^{238}U have been performed. Typical yields of the experiments were, e.g., about 150 atoms/μC, 800 atoms/μC and 6000 atoms/μC for ^{88}Se, ^{88}Br and ^{88}Kr, respectively. Although several γ-ray peaks having half-lives less than one second were detected by a high-efficiency β-γ coincidence detector system consisting of a 4π thin plastic scintillator and a 250 cc HP-Ge detector, it can not be supported yet that those γ-rays come from unknown ^{88}As because of low statistics.

d. The Decay Properties of the Giant Dipole Resonance of the ^{19}F Nucleus (E. Tanaka, K. Kageyama, N. Kumagai* and G. Isoyama**, *KEK, **ISSP, Univ. of Tokyo)

In order to study microscopic feature of the giant dipole resonance (GDR) of ^{19}F, we have measured the energy spectra of prompt deexcitation γ-rays using bremsstrahlung with end-point energies ranging from 12 to 26 MeV. The yield curves for production of γ-rays from the residual states in ^{18}O, ^{18}F, ^{17}O and ^{15}N were analyzed. We have then deduced the integrated cross sections for population to these residual states after correction for cascade transitions involved. We have also determined the summing cross sections for transitions to excited states in each residual nucleus. Comparisons of these data with S-factors, other photonuclear cross sections and Hauser-Feshbach predictions enable us to draw the following conclusions. The direct-semidirect decays dominate in the low-energy region (peak at 20 MeV) of the GDR containing the transitions $1p_{1/2} \rightarrow 2s1d$ and $2s1d \rightarrow 1f2p$, while the statistical decays dominate in the high-energy region (peak at about 25 MeV) of the transitions $1p_{3/2} \rightarrow 2s1d$. It is therefore confirmed to be a configurational splitting of the ^{19}F GDR.

e. Detection of γ-rays from the 275.4 keV Isomer in ^{212}At for Measurement of the Nuclear g-Factor (S. Hayashibe, N. Kawamura, E. Tanaka, M. Kanazawa and M. Fujioka)

In previous experiments, we measured the g-factor of the 275.4 keV 5^- isomer in ^{212}At by the time-differential perturbed angular distributions of the 160.4 keV γ-ray in the $69.9 \rightarrow 45.1 \rightarrow 160.4$ keV cascade transition from the isomer, because the two upper γ-rays were very weak due to strong internal conversion. The ^{212}At nuclei were populated by the $^{209}Bi(\alpha,n)^{212}At$ reaction using a 22 MeV α-beam from the CYRIC cyclotron.

In order to investigate a possibility of better determination of the g-factor by the two upper transitions, a reexperiment was performed using an Os absorber to reduce the background due to the huge K-Xrays from the Bi target. The two γ-rays of 69.9 and 45.1 keV have been observed. However, further

improvement is required to determine these angular distribution coefficients and to use them for g-factor measurements.

f. Measurements of the Gamma-Ray Branching of the Mirror Decay of Mass Separated ^{57}Cu (H. Ikegami, M. Wada, H. Sunaoshi, T. Shinozuka* and M. Fujioka, *CYRIC)

^{57}Cu was produced by the ^{58}Ni(p,n) reaction and on-line mass separated by the IGISOL, and transported quickly to the detector station with the improved tape-transport system. The decay of ^{57}Cu was studied with β-γ spectroscopy and the weak β-branch to the 1111 keV state of ^{57}Ni was measured to be 5.7±0.6 %, from which experimental values of $\langle\sigma\tau\rangle$ matrix elements were obtained and compared with theory.

g. Measurement of Nuclear Charge Dispersion of Fission Products by Use of IGISOL (H. Kudo*, Y. Horikoshi*, M. Tanikawa*, Y. Kaneko*, T. Hashimoto*, M. Fujioka, T. Shinozuka**, M. Wada, H. Ikegami and H. Sunaoshi, *Niigata Univ., **CYRIC)

Nuclear charge dispersion for the charged-particle-induced fission, ^{238}U(p,f), using the IGISOL for on-line mass separation of fission products. Applicability of IGISOL to such studies was demonstrated, and the width and the most probable charge Z_p of mass dispersion for A=138-149 were determined assuming a Gaussian shape and using a method of taking ratios. Increment of Z_p was shown to vary from mass to mass.

h. Construction of an Ion Trap for Nuclear Spectroscopy using a Laser-Microwave Double-Resonance Method (M. Wada, H. Ikegami, T. Shinozuka*, M. Fujioka, M. Yagi**, S. Matsuki*** and S. Hayashibe, *CYRIC, **Research Inst. for Iron, Still & Other Metals, ***RCNP)

An RF-type ion trap was constructed for nuclear spectroscopy in terms of hyperfine interactions of trapped ions. The trapped ions of N_2^+ and Kr^+ were successfully detected with an external resonance circuit, and trap parameters were determined. The SHG (Second Harmonics Generation) method was tested to generate 421 nm light from the 842 nm laser light by using a non-linear optical element of $KNbO_3$ with a successful result. The 421 nm light will be used for resonance excitation of the $5S_{1/2}\rightarrow 5P_{1/2}$ transition of Sr^+.

i. Study of the Ion Optics of the JHP-ISOL (M. Fujioka, T. Shinozuka*, T. Nomura**, N. Ikeda**, H. Wollnik***, H. Nestle*** and S. Meuser***, *CYRIC, **INS, **Univ. Giessen)

An ion-optical design was proposed for the JHP-ISOL intended for delivering high-quality radioisotope beams of 60-120 keV for subsequent acceleration to 6.5 MeV/amu an well as for direct use. The design goal of the separator is to realize a mass-resolving power of $R_M=2\times10^4$ at a transmission T≃100 %, and an ultimate resolution of $R_M=3\times10^4$ for separating adjacent short-lived isobars.

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5) Physical Properties of Sm_3Se_4 at Low Temperatures, T. Furuno, K. Ando, S. Kunii, A. Ochiai, H. Suzuki, M. Fujioka, T. Suzuki, W. Sasaki and T. Kasuya, J. Magn. Magn. Mat. 76/77 (1988) 117.

Master Thesis (March 1989)

M1) Measurement of the Gamma-Ray Branching of the Mirror Decay of Mass Separated ^{57}Cu, Hitoshi Ikegami.